

C-4160 Log Data Report

Borehole Information:

Borehole: C-4160		Site: 216-A-36B Crib			
Coordinates (WA St Plane)		GWL¹ (ft):	Not applicable	GWL Date:	08/05/03
North 135294.918	East 575105.065	Drill Date 08/03	Ground Level Elevation Not available	Total Depth (ft) 321.0	Type Cable

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	0.2	11	9 3/4	5/8	+0.2	93
Threaded steel	1.05	9	8	1/2	+1.05	147
Threaded steel	2.30	6 1/2	5 1/2	1/2	+2.30	321

Borehole Notes:

The logging engineer measured the casing stickup using a steel tape. A caliper was used to measure the outside casing diameters. The caliper and inside casing diameters were measured using a steel tape. Measurements are rounded to the nearest 1/16 inch. The Fluor Hanford drilling supervisor provided the total drilling depth, depth to water, and borehole coordinates. Ground level elevation was not available. Logging data acquisition is referenced to the ground surface.

Spectral Gamma Logging System (SGLS) Equipment Information:

Logging System: Gamma 1E	Type: SGLS (70%) SN: 34TP40587A
Calibration Date: 07/03	Calibration Reference: GJO-2003-468-TAC
	Logging Procedure: MAC-HGLP 1.6.5, Rev. 0

Logging System: Gamma 2E	Type: SGLS (70%) SN: 34TP40587A
Calibration Date: 03/03	Calibration Reference: GJO-2003-430-TAC
	Logging Procedure: MAC-HGLP 1.6.5, Rev. 0

High Rate Logging System (HRLS) Equipment Information:

Logging System: Gamma 1C	Type: HRLS SN: 39A314
Calibration Date: 04/03	Calibration Reference: GJO-2003-429-TAC
	Logging Procedure: MAC-HGLP 1.6.5, Rev. 0

Neutron Moisture Logging System (NMLS) Equipment Information:

Logging System:	Gamma 2F	Type:	NMLS SN: H380932510
Calibration Date:	04/03	Calibration Reference:	GJO-2002-387-TAC
	Logging Procedure: MAC-HGLP 1.6.5, Rev. 0		

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	3	4 Repeat	9	10 Repeat	15
Date	08/05/03	08/05/03	08/09/03	08/09/03	09/02/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Pearson
Start Depth (ft)	0.0	40.0	145.0	101.0	319.0
Finish Depth (ft)	93.0	50.0	92.0	95.0	144.0
Count Time (sec)	100	100	100	100	100
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
ft/min	N/A ²	N/A	N/A	N/A	N/A
Pre-Verification	BE060CAB	BE060CAB	BE061CAB	BE061CAB	AE030CAB
Start File	BE060000	BE060094	BE061000	BE061054	AE030000
Finish File	BE060093	BE060104	BE061053	BE061060	AE030175
Post-Verification	BE060CAA	BE060CAA	BE061CAA	BE061CAA	AE030CAA
Depth Return Error (in.)	N/A	-1	N/A	0	N/A
Comments	Gamma 2E. Fine-gain adjustment after file -047.	Gamma 2E. Fine-gain adjustment after file -098.	Gamma 2E. No fine-gain adjustment.	Gamma 2E. No fine-gain adjustment.	Gamma 1E. Fine-gain adjustments after files -096 and -160.

Log Run	16 Repeat				
Date	09/02/03				
Logging Engineer	Pearson				
Start Depth (ft)	168.0				
Finish Depth (ft)	150.0				
Count Time (sec)	100				
Live/Real	R				
Shield (Y/N)	N				
MSA Interval (ft)	1.0				
ft/min	N/A				
Pre-Verification	AE030CAB				
Start File	AE030176				
Finish File	AE030194				
Post-Verification	AE030CAA				
Depth Return Error (in.)	-1				
Comments	Gamma 1E. No fine-gain adjustment.				

High Rate Logging System (HRLS) Log Run Information:

Log Run	5	6	7	8	
Date	08/06/03	08/06/03	08/06/03	08/06/03	
Logging Engineer	Kos	Kos	Kos	Kos	
Start Depth (ft)	23.0	28.0	35.0	48.0	
Finish Depth (ft)	27.0	34.0	37.0	51.0	
Count Time (sec)	300	100	300	300	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A	N/A	N/A	N/A	
Pre-Verification	AC076CAB	AC076CAB	AC076CAB	AC076CAB	
Start File	AC076000	AC076005	AC076012	AC076015	
Finish File	AC076004	AC076011	AC076014	AC076018	
Post-Verification	AC076CAA	AC076CAA	AC076CAA	AC076CAA	
Depth Return Error (in.)	N/A	N/A	N/A	-0.25	
Comments	None	Counting time change.	Counting time change.	None	

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2 Repeat	11	12 Repeat	13
Date	08/05/03	08/05/03	08/09/03	08/09/03	08/28/03
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Kos
Start Depth (ft)	0.0	22.0	92.5	95.0	144.0
Finish Depth (ft)	93.5	32.0	145.0	101.0	320.0
Count Time (sec)	N/A	N/A	N/A	N/A	N/A
Live/Real	L	L	L	L	L
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25	0.25
ft/min	1	1	1	1	1
Pre-Verification	AC071CAB	AC071CAB	AC072CAB	AC072CAB	AC079CAB
Start File	AC071000	AC071375	AC072000	AC072211	AC079000
Finish File	AC071374	AC071415	AC072210	AC072235	AC079704
Post-Verification	AC071CAA	AC071CAA	AC072CAA	AC072CAA	AC079CAA
Depth Return Error (in.)	N/A	0	N/A	0	N/A
Comments	None	None	None	None	None

Log Run	14 Repeat				
Date	08/28/03				
Logging Engineer	Kos				
Start Depth (ft)	295.0				
Finish Depth (ft)	277.0				
Count Time (sec)	N/A				
Live/Real	L				
Shield (Y/N)	N				
MSA Interval (ft)	0.25				
ft/min	1				
Pre-Verification	AC079CAB				
Start File	AC079705				
Finish File	AC079776				
Post-Verification	AC079CAA				
Depth Return Error (in.)	-2				
Comments	None				

Logging Operation Notes:

Logging was performed in this borehole between August 4, and September 3, 2003. Sixteen log runs were performed with four separate logging systems. These systems are referred to as SGLS 1E (2 log runs), SGLS 2E (4 log runs), NMLS 2F (6 log runs), and HRLS 1C (4 log runs). Measurements were acquired in a single casing string as the borehole was advanced to prevent logging in dual casing configurations that affect log data quality. Logging was conducted with a centralizer on each sonde. Measurements are referenced to ground surface. Repeat sections were collected in this borehole for all systems except for the HRLS to evaluate each logging system's performance.

During logging on August 5 and 6 (log runs 1 to 8, log depth 0 to 93 ft), a plastic bag was placed over the sondes to prevent possible contamination. The borehole had been designated a "contaminated area." This designation was removed prior to the next logging run conducted August 9.

Analysis Notes:

Analyst:	Henwood	Date:	09/09/03	Reference:	GJO-HGLP 1.6.3, Rev. 0
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Pre-run and post-run verifications for the logging systems were performed before and after data acquisition. Acceptance criteria were met.

A casing correction for 0.6250-in.-thick casing was applied to the spectral log data (SGLS and HRLS) from 0 to 93 ft. Below 93 ft, a correction for 0.5-in.-thick casing was applied. No corrections were applied to the NMLS data because calibrations are not available for all the various casing diameters and thicknesses that existed in this borehole. Moisture data are presented in counts per second and reflect relative moisture content.

SGLS and HRLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL worksheet templates identified as G1EJul03.xls and G2EMar03.xls for the SGLSs, and G1CApr03.xls for the HRLS using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied where dead times exceed 10.5 percent. Where SGLS dead time exceeds 40 percent, HRLS data are substituted. Correction for water was not needed in this borehole.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{137}Cs and ^{60}Co) detected in the borehole, naturally occurring radionuclides (^{40}K , ^{238}U , ^{232}Th [KUT]), a combination of man-made, KUT, and moisture, and total gamma plotted with dead time. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. Repeat log sections are also included where appropriate.

Results and Interpretations:

^{137}Cs was detected in this borehole near the ground surface between 0 and 5 ft at less than 10 pCi/g. ^{137}Cs was also measured between 20 and 95 ft with a maximum concentration of approximately 2 million pCi/g at 27 ft. The highest concentration zones lie between 24 and 37 ft and 48 and 51 ft. ^{60}Co was detected between 38 and 60 ft in depth and at sporadic locations to 116 ft. The maximum ^{60}Co concentration is approximately 1.5 pCi/g at 50 ft in depth. It is likely ^{60}Co also exists in the high ^{137}Cs concentration zone between 24 and 37 ft. The MDL for ^{60}Co is greatly increased in this high activity zone.

It is likely some casing contamination occurred during drilling of this borehole. This contamination could be the result of dragdown of material on the outside of the casing, contamination from sampling equipment inside the casing, or both. This is postulated because the ^{137}Cs contamination ends at approximately the depth where the first string of casing existed from 0 to 93 ft. However, ^{60}Co extends to greater depths than 93 ft, suggesting some contamination could reside in the formation.

The naturally occurring ^{238}U exhibits a relatively higher concentration between 0 and 93 ft than in the remainder of the borehole. This higher concentration is probably the result of enhanced radon.

The relative moisture content does not appear to vary significantly throughout the borehole except at a depth of 289 ft. The higher moisture coincides with a relatively higher ^{232}Th concentration, suggesting a clayey material exists at this depth.

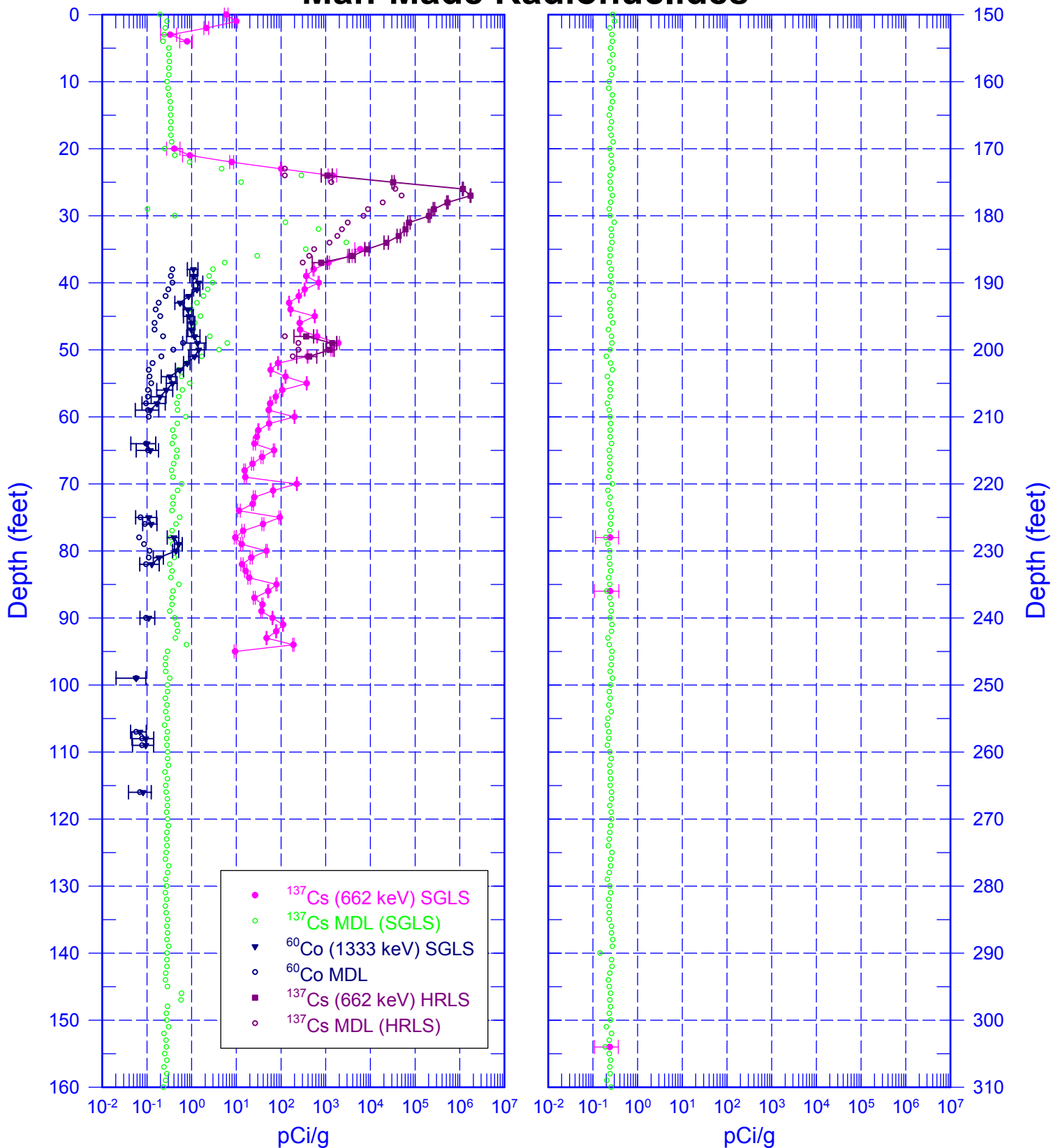
The repeat sections for the SGLSs and NMLS indicate good agreement.

¹ GWL – groundwater level

² N/A – not applicable

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Man-Made Radionuclides



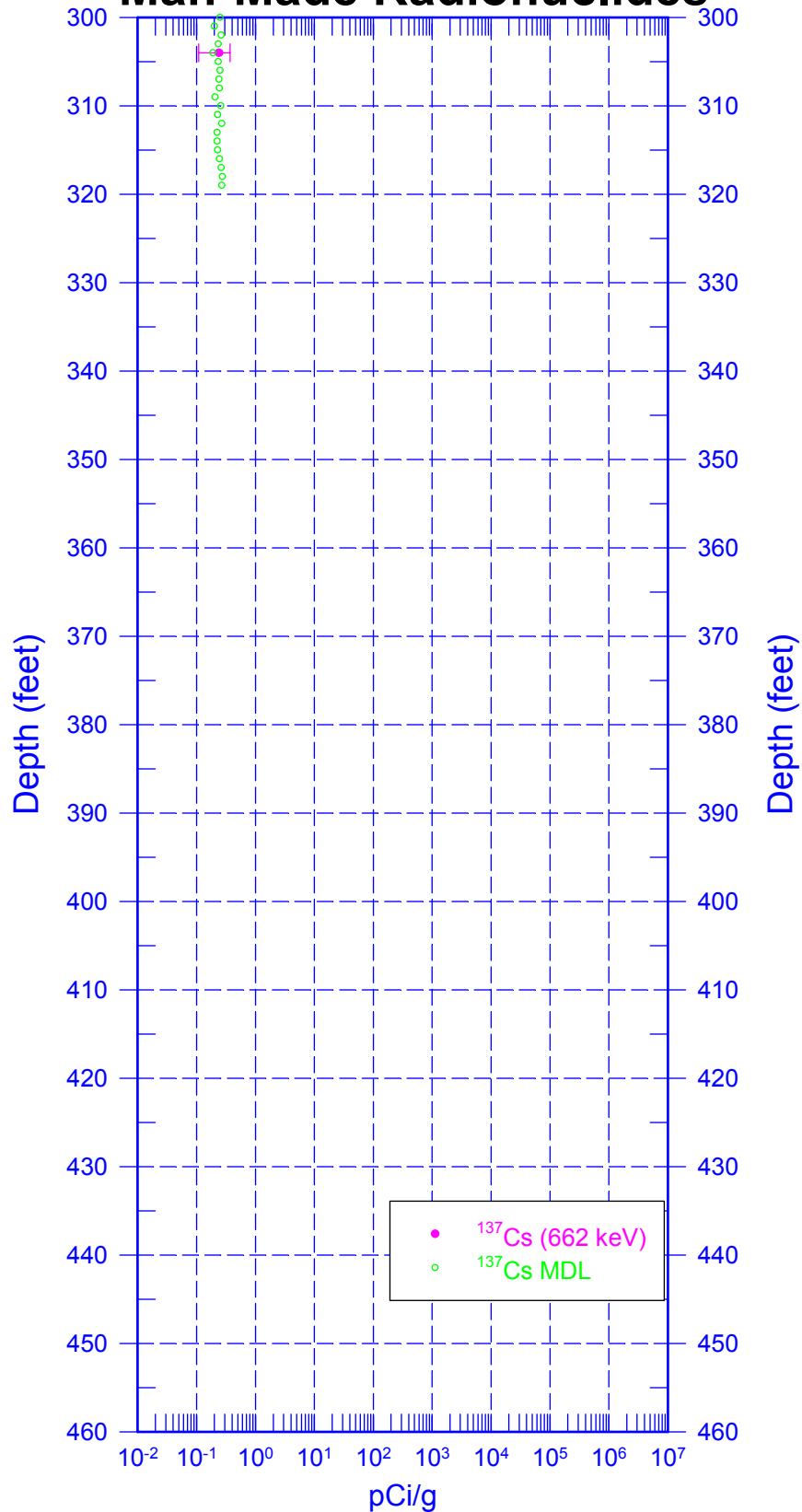
Zero Reference = Ground Surface

Depth Scale: 1"=20 ft

Last Log Date - 09/02/03

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Man-Made Radionuclides



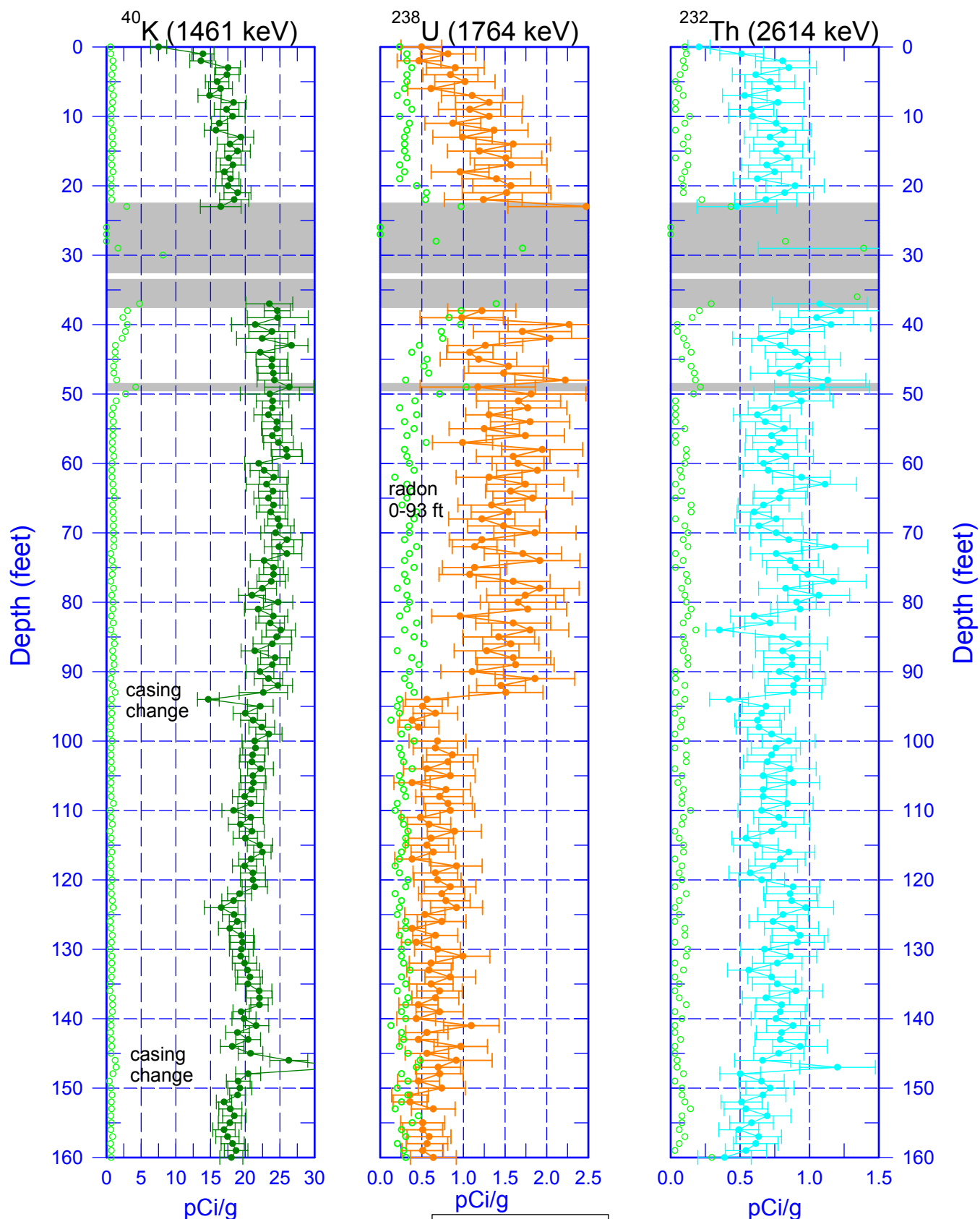
Zero Reference = Ground Surface

Depth scale: 1"=20 ft

Last Log Date - 09/02/03

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Natural Gamma Logs

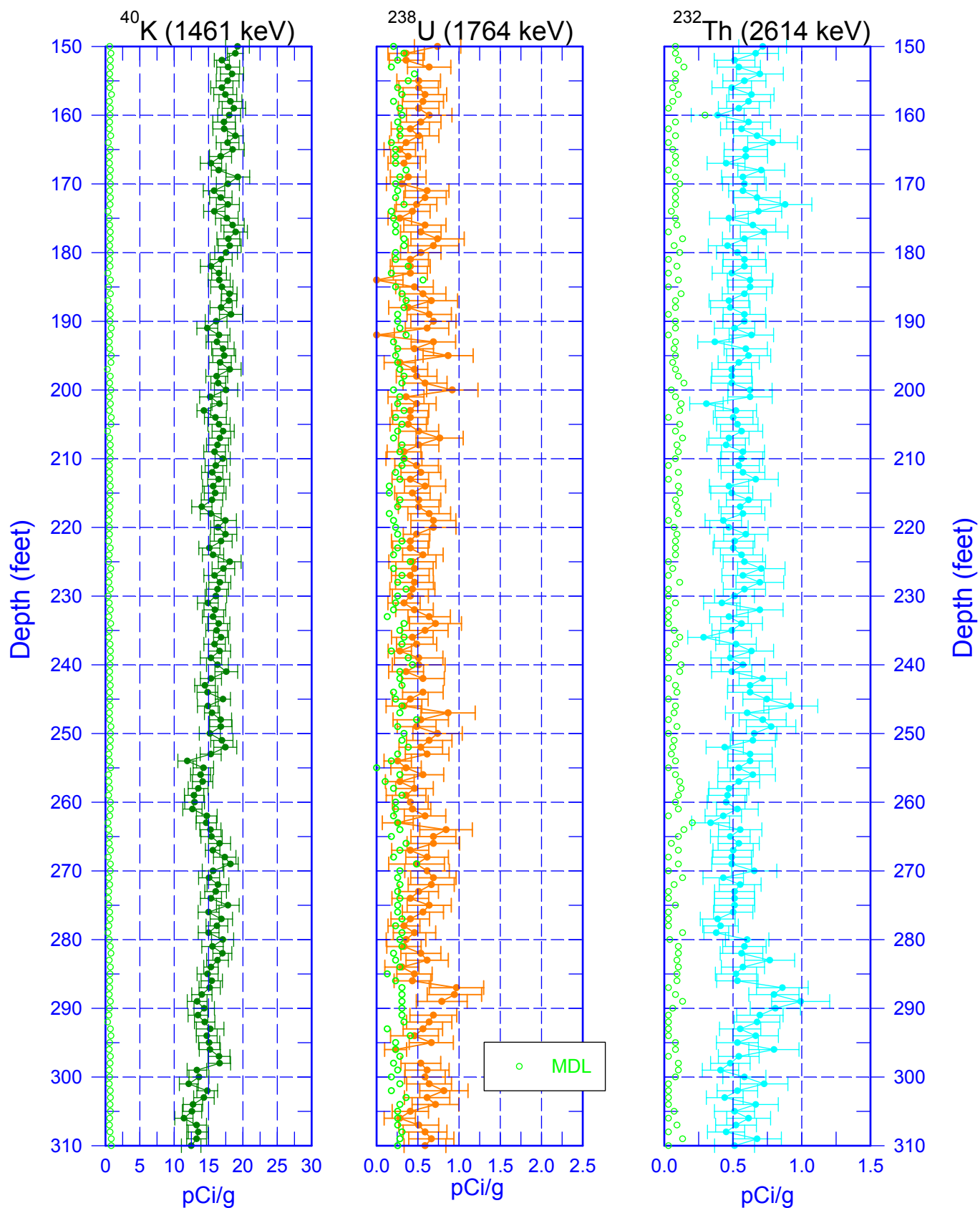


Zero Reference = Ground Surface

Last Log Date - 09/02/03

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Natural Gamma Logs



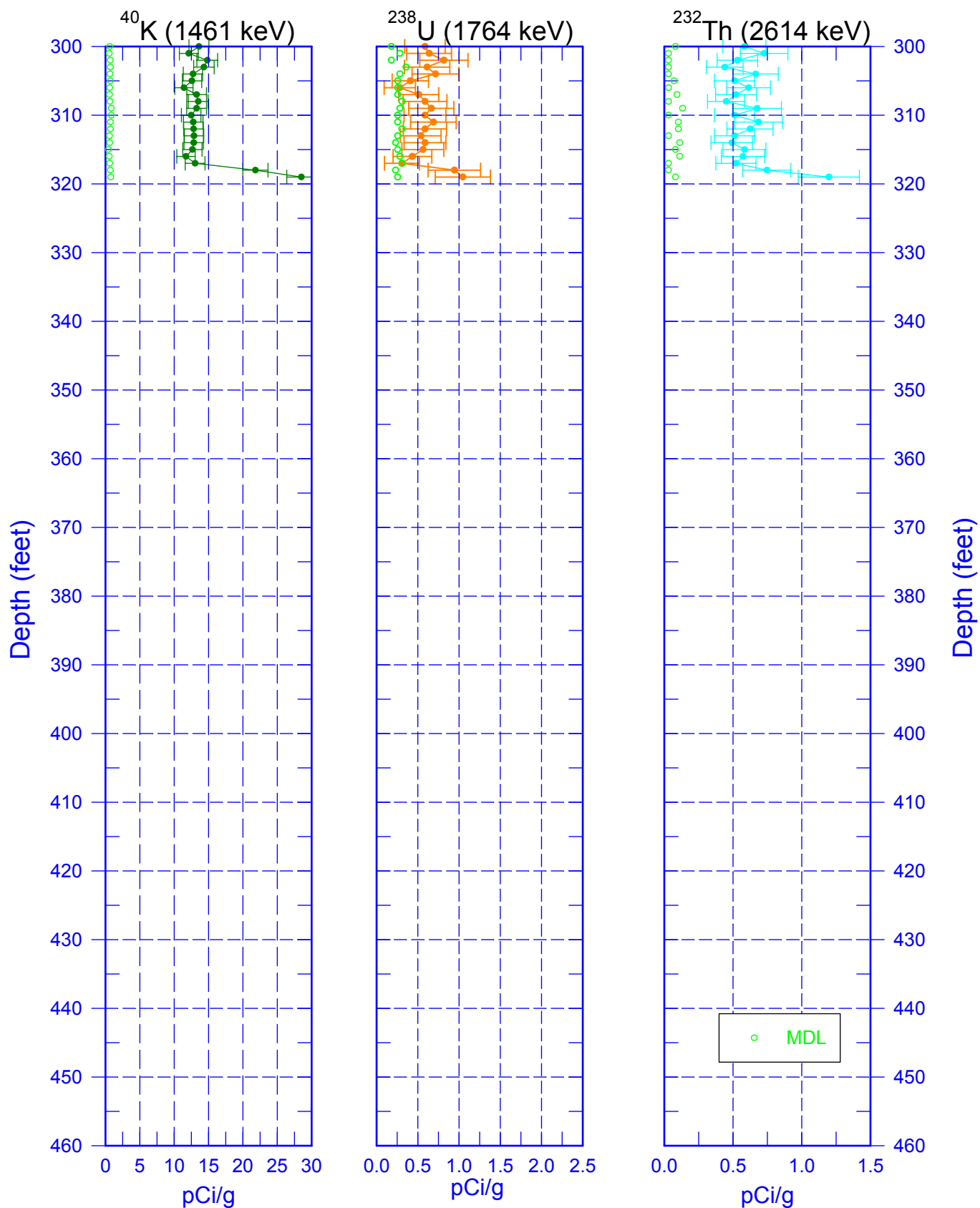
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Depth scale: 1"=20 ft

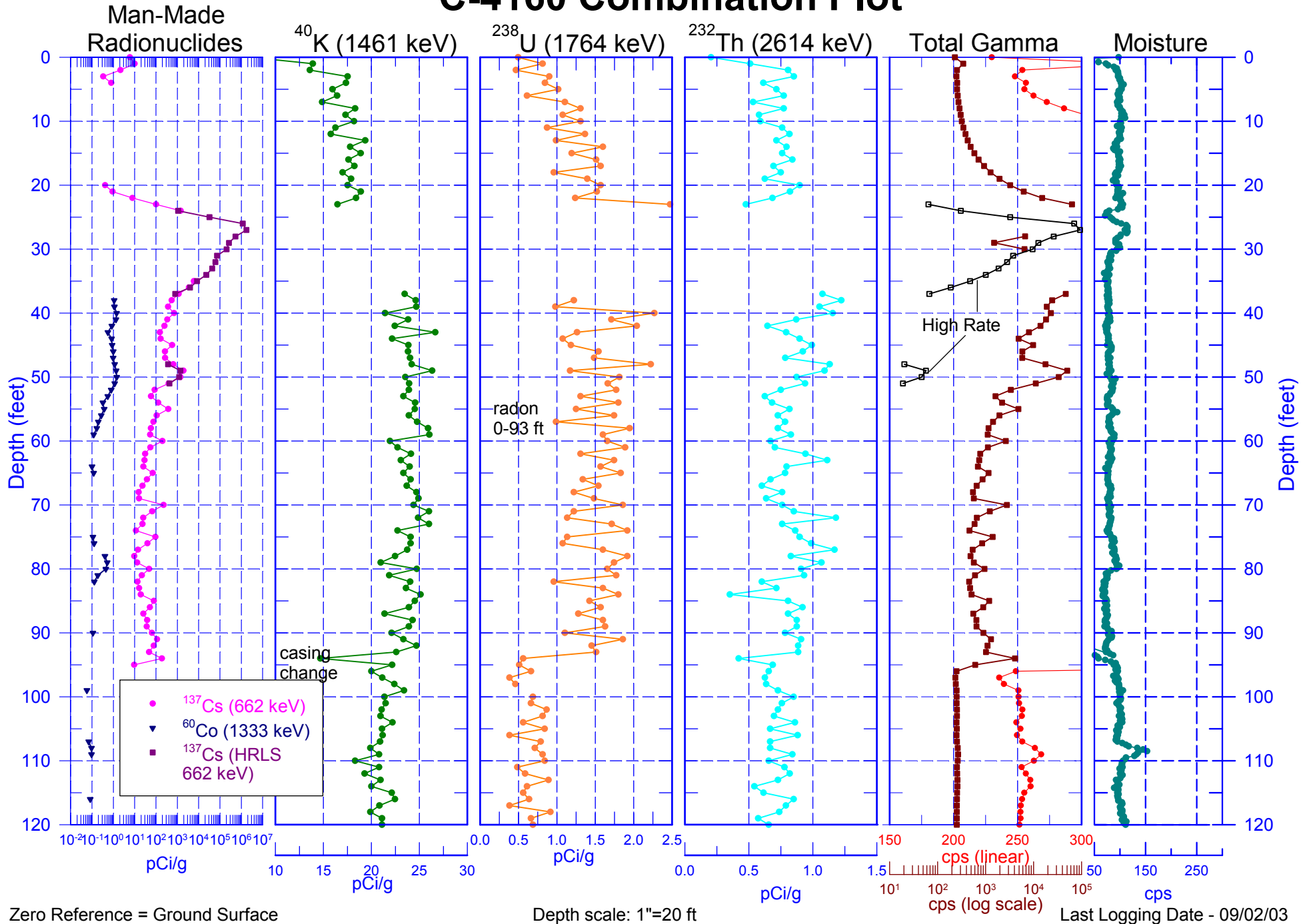
Last Log Date - 09/02/03

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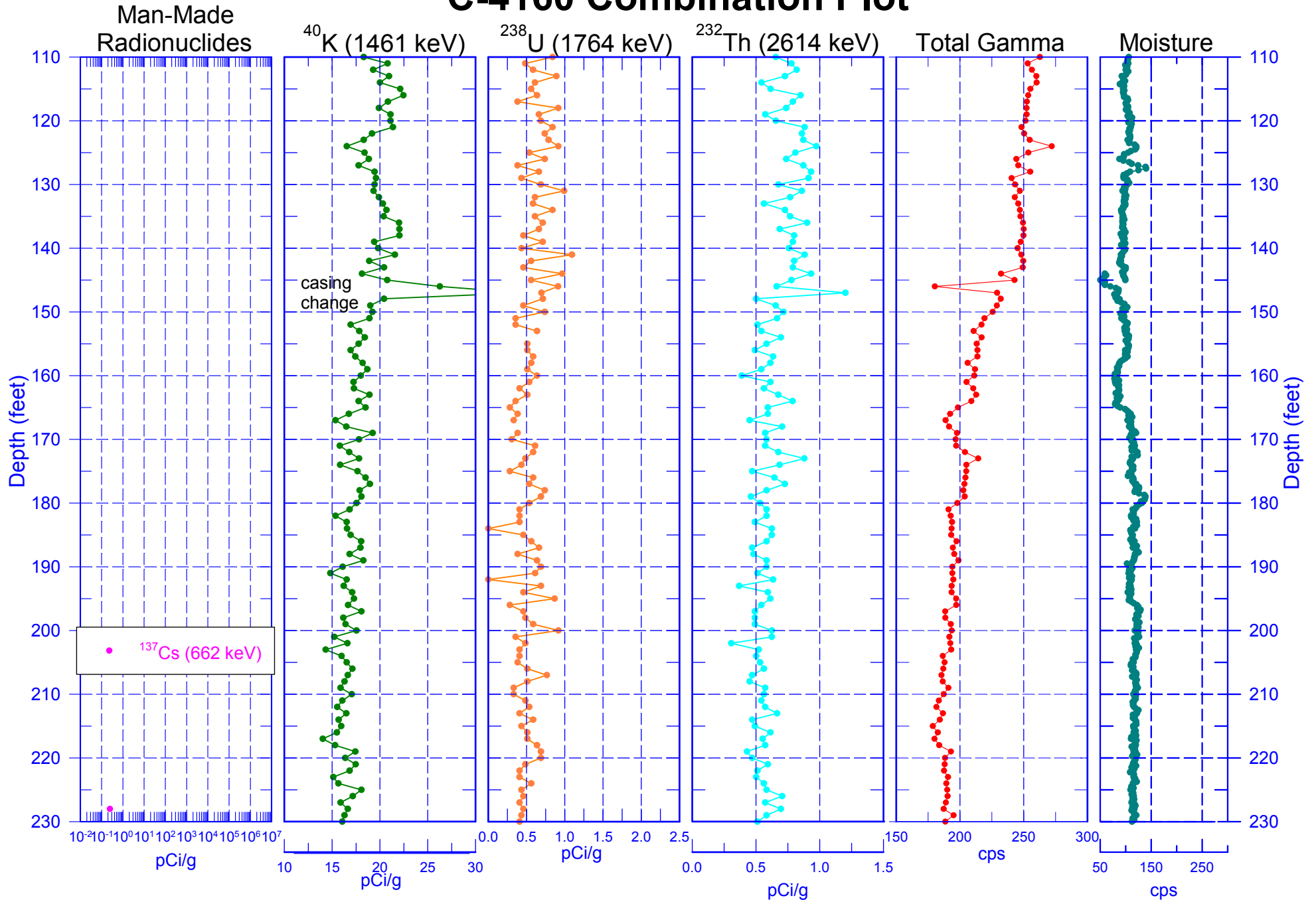
Natural Gamma Logs



C-4160 Combination Plot



C-4160 Combination Plot

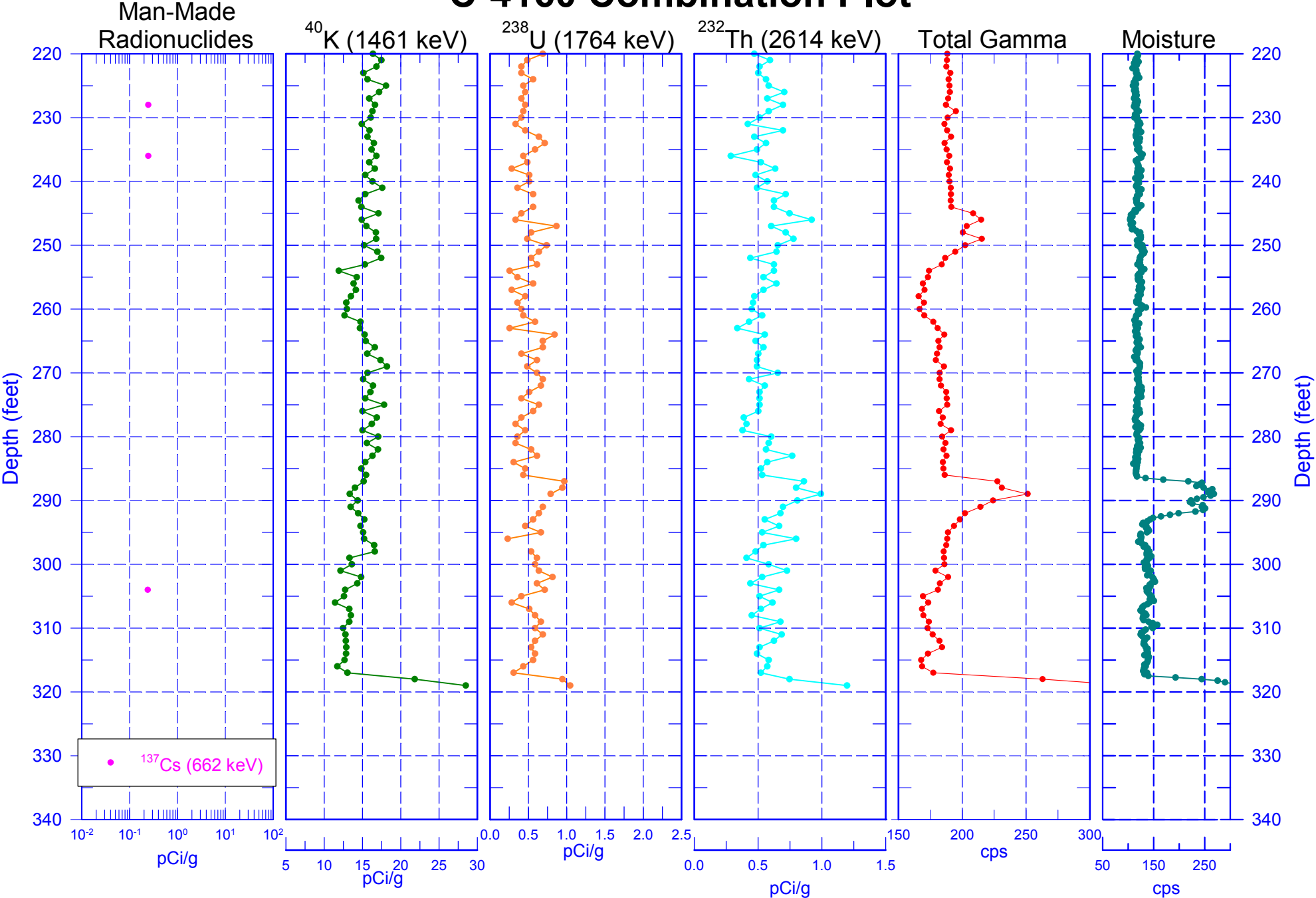


Zero Reference = Ground Surface

Depth scale: 1"=20 ft

Last Logging Date - 09/02/03

C-4160 Combination Plot



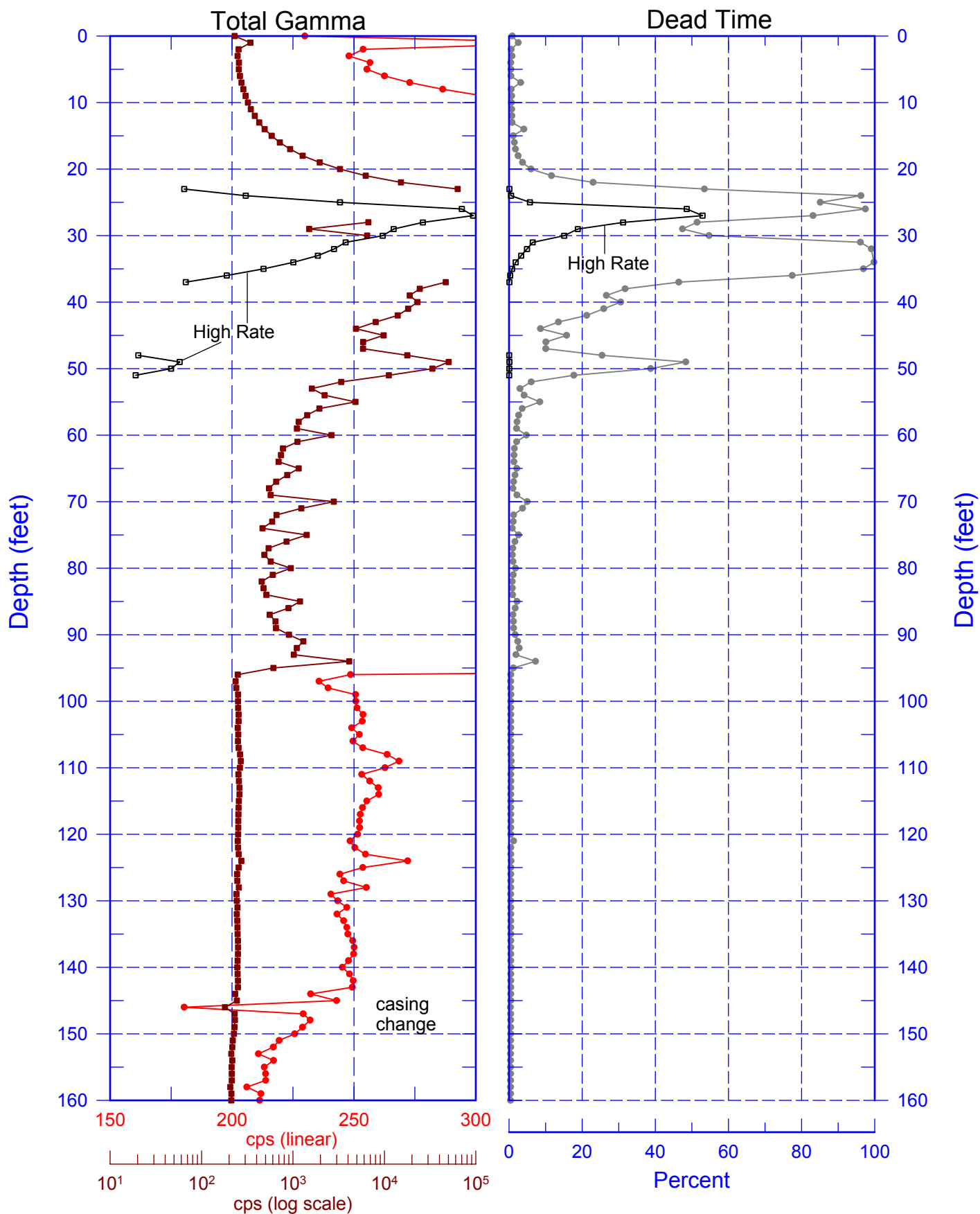
Zero Reference = Ground Surface

Depth scale: 1"=20 ft

Last Logging Date - 09/02/03

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Total Gamma & Dead Time



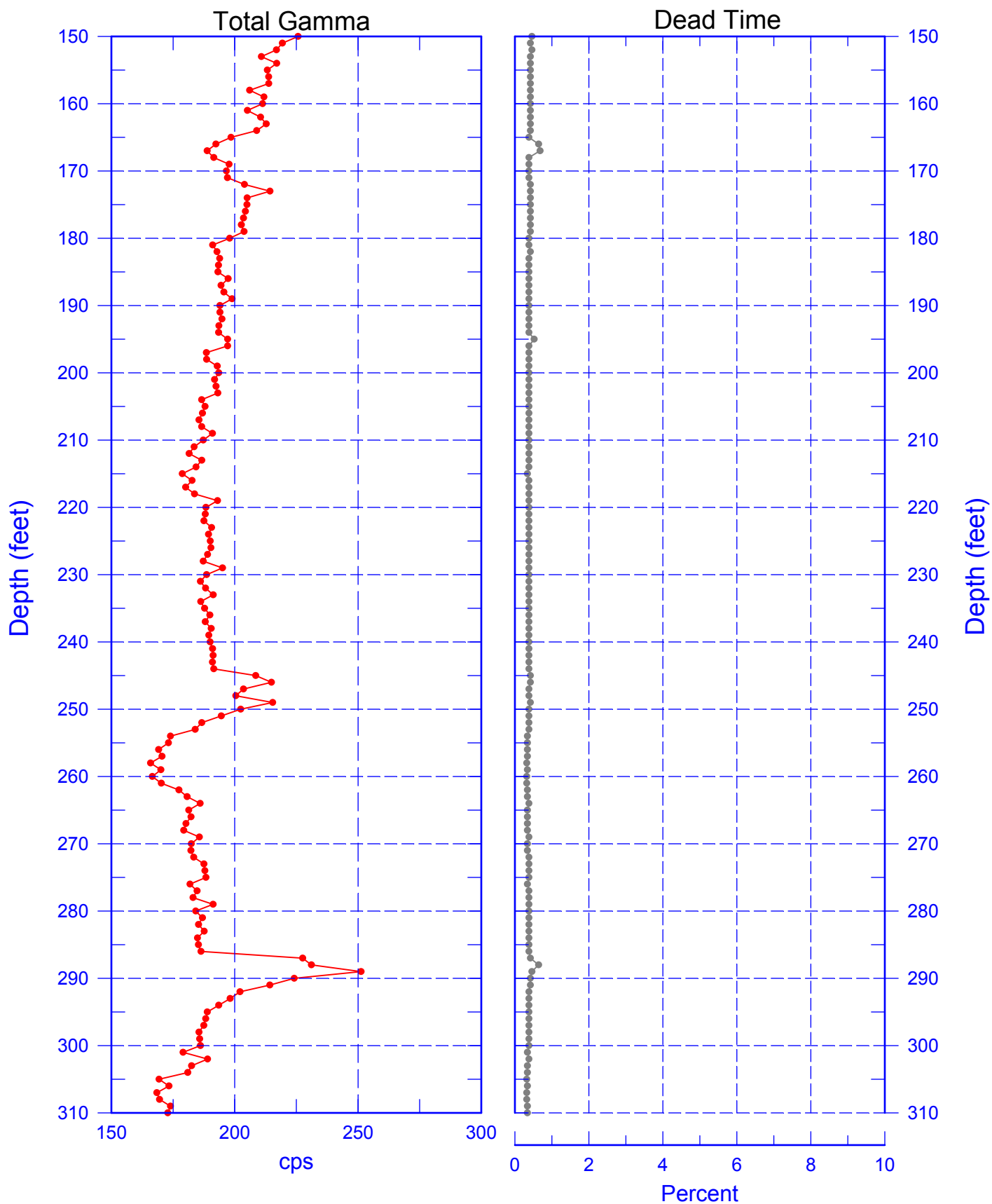
Depth scale: 1"=20 ft

Reference - Ground Surface

Last Log Date - 09/02/03

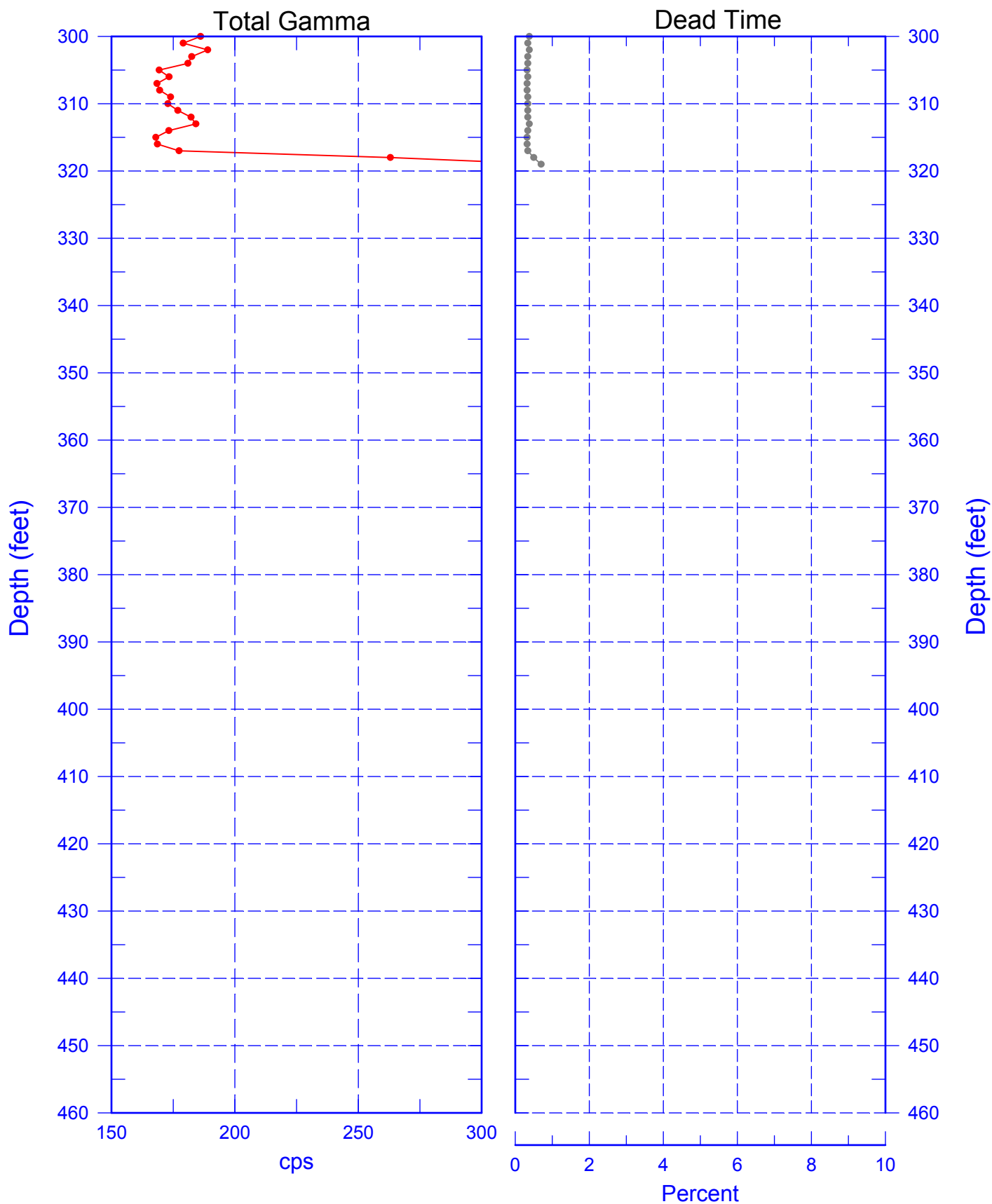
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Total Gamma & Dead Time



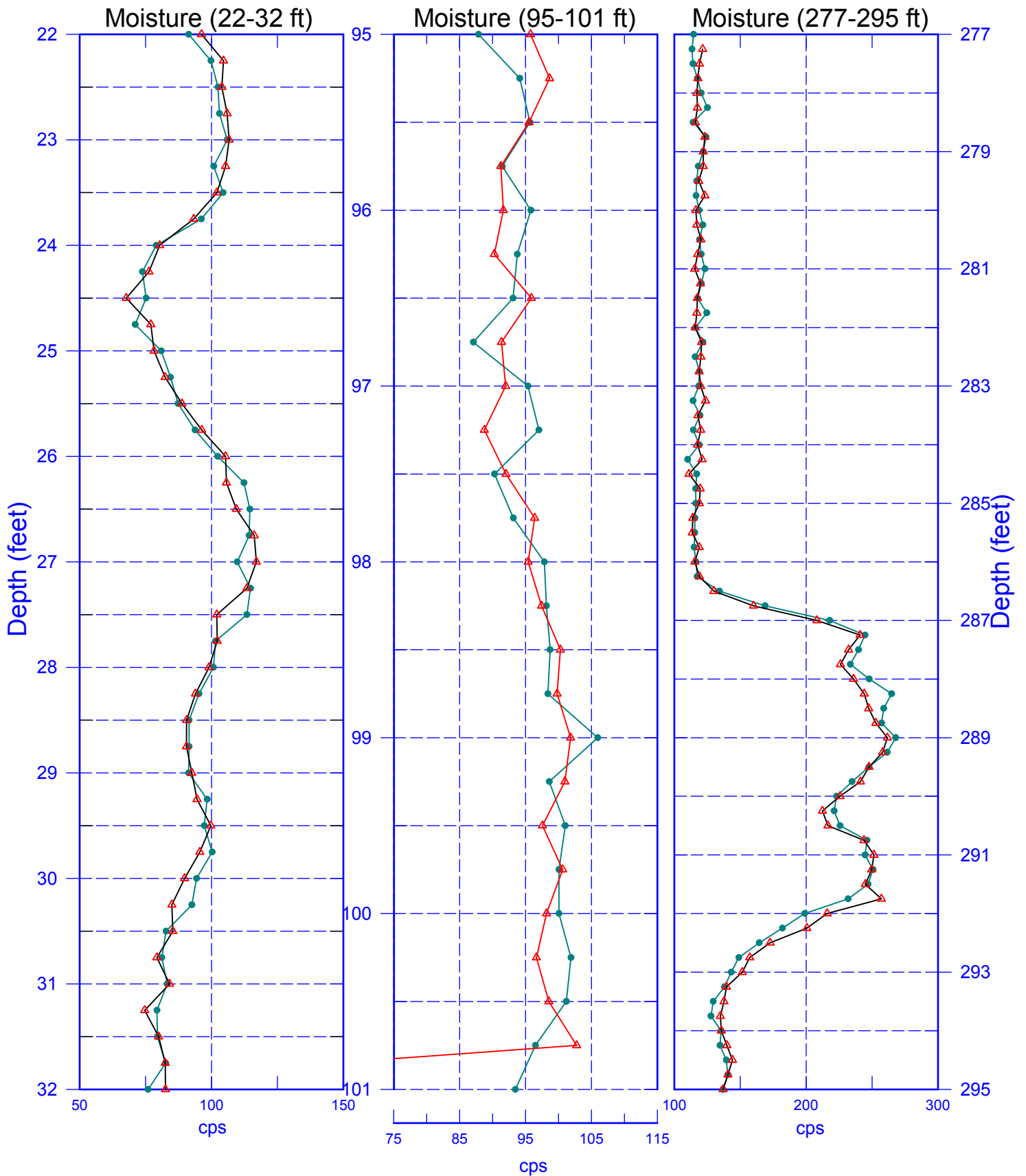
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Total Gamma & Dead Time



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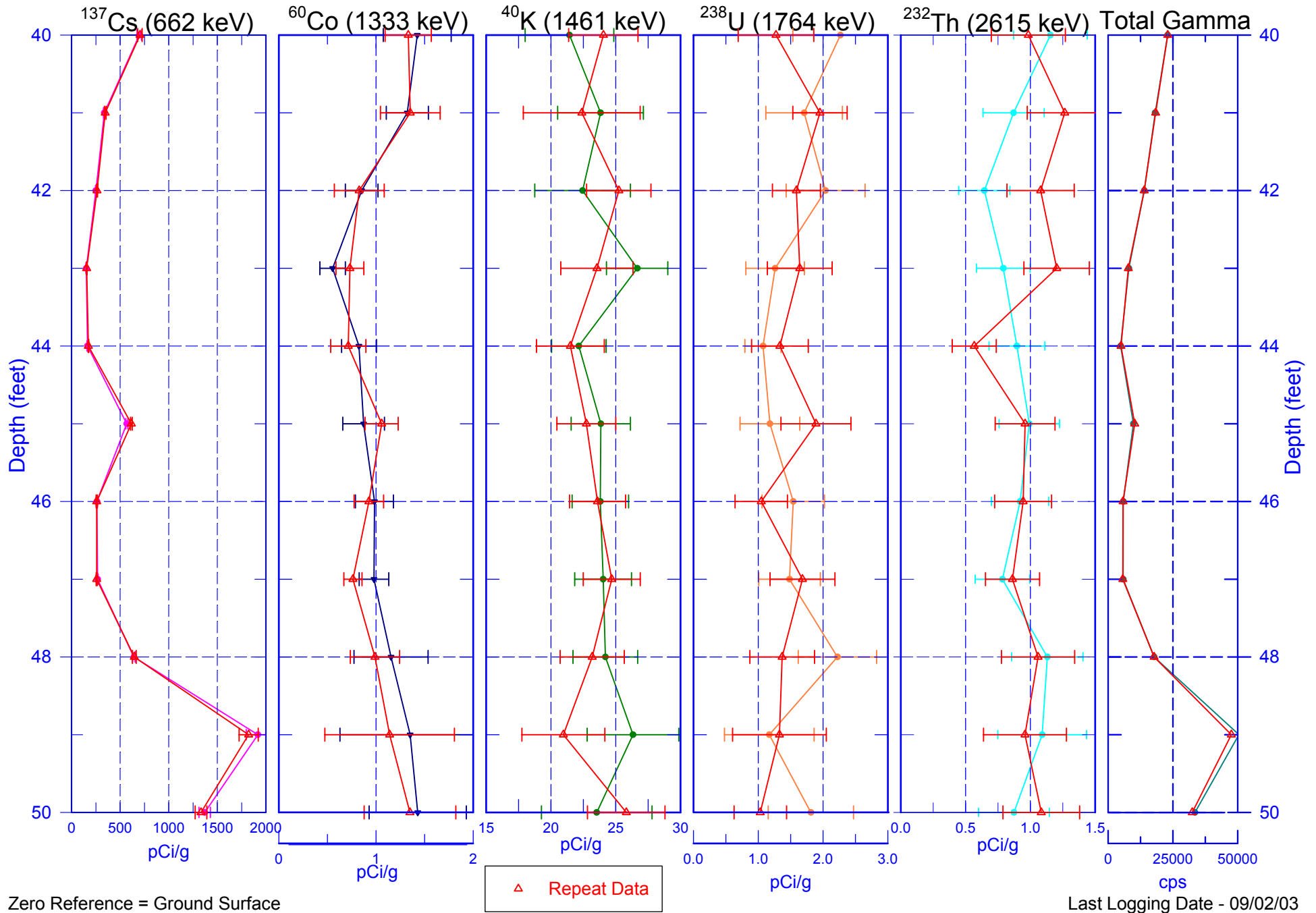
Repeat Sections of Moisture



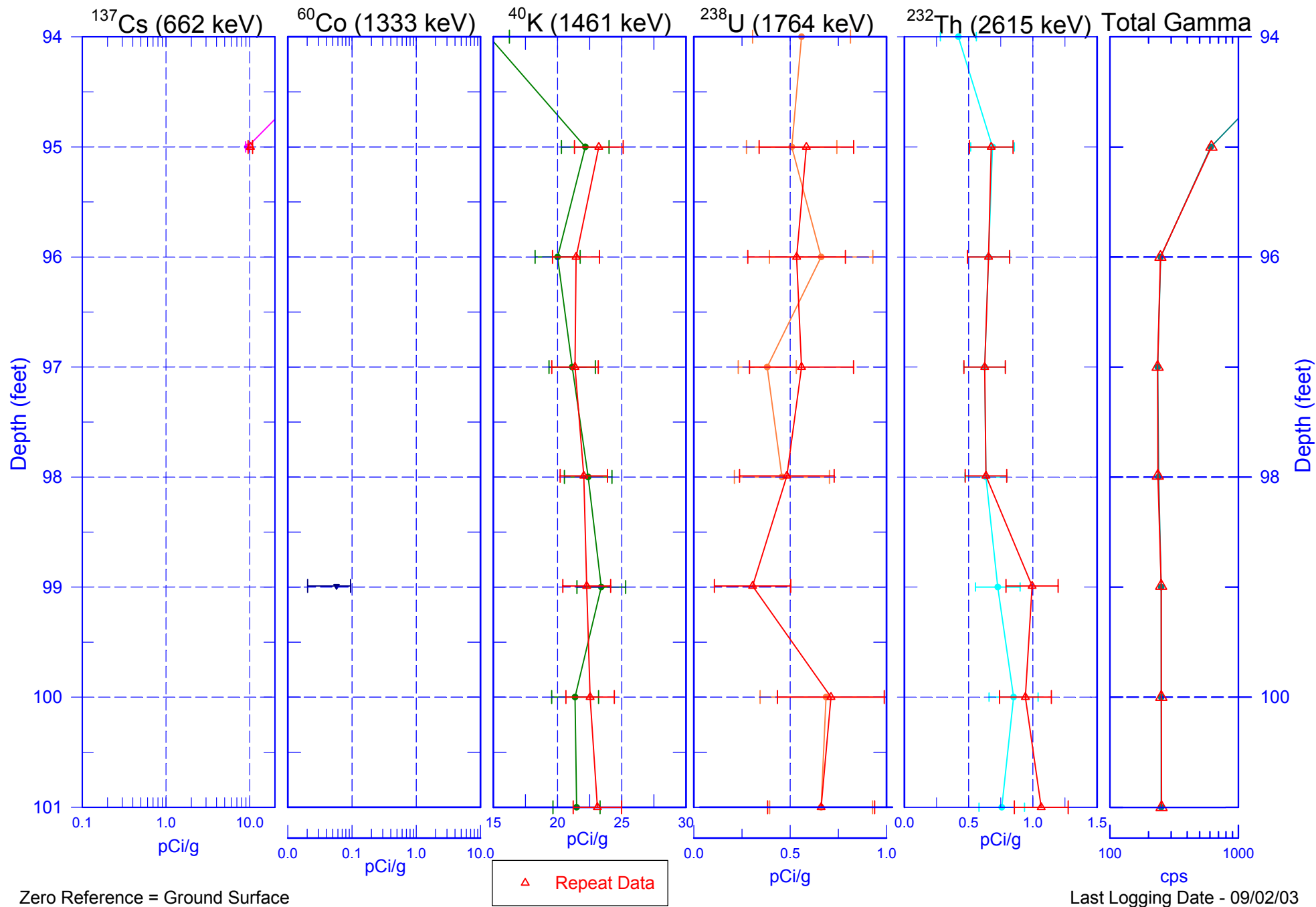
Zero Reference = Ground Surface

Last Log Date - 09/02/03

C-4160 Repeat Section



C-4160 Repeat Section



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Repeat Section of Natural Gamma Logs

